Abstract: A hybrid resonant DC-DC converter with an active voltage doublers rectifier is proposed to develop thermo electric power conditioning systems that are highly efficient over a wide range of input voltages that support medium rated power. When the input voltage is higher than the preset nominal input voltage, the converter operates in the phase shift full-bridge resonant converter mode, in which it achieves high efficiency by softly switching the primary side switches and reducing the condition loss. When the input voltages lower than the nominal one, it operates in the resonant boost mode that boosts the resonant inductor current. By using the active voltage-doublers rectifier on the secondary side of the converter, we can build the converter with less number of active components. As a result, the proposed converter achieves at low cost, high boost-ratio and high efficiency over a wide range of input voltages. Detailed analysis of the converter operation is presented along with the design procedure. At 35-55 V, a 600-W/360-V prototype of the proposed converter has been built and tested a demonstrate its effectiveness.

Keywords: Energy storage system, circulating energy, voltage spike

INTRODUCTION

When the input voltage is higher than the preset nominal input voltage, the converter operates in the phase-shift full-bridge series-resonant converter (PSFB-SRC) mode, in which it achieves high efficiency by softly switching the primary side switches and reducing the conduction loss. When the input voltage is lower than the nominal one, it operates in the resonant boost mode that boosts the resonant inductor current. By using the active voltage-doublers rectifier on the secondary side of the converter, we can build the converter with less number of active components. As a result, the proposed converter achieves, at low cost, high boost-ratio and high efficiency over a wide range of input voltages. Detailed analysis of the converter operation is presented along with the design procedure. Approximately 20-50% of the energy consumed by the manufacturing industry is wasted as thermal losses. To harvest this wasted thermal energy, several kilowatts-level thermoelectric (TE) power systems have been developed and operated. In TE power systems, TE modules are combined with grid-connected inverters to deliver generated electrical energy to the utility grid. The module integrated converter (MIC) enables individual operation of each TE module and reduces power losses caused by mismatch between the modules (Fig. 1a). In addition, it is easy to maintain because it provides “plug and play” feature and prevents system malfunction caused by single point of failure. Each TE module operates at medium power capacity (~500W) and at low output voltage that varies in a predetermined range (30 V – 65 V) at different temperatures (Fig. 1b). Thus, the MIC is required to step-up the low output voltage of the TE so that it can link to the high-voltage dc bus that feeds the inverter stage. The MIC must also be able to operate over a wide range of input voltages to track the maximum power point (MPP) for different types of TE modules operating under different environmental conditions. When the input voltage is higher than the nominal input voltage, this converter operates in PSFB-SRC mode that achieves high power conversion efficiency by softly switching the primary side switches and reducing the conduction loss; otherwise, the converter operates in the resonant boost mode that can boost the resonant inductor current by using the active voltage-doubler rectifier on the secondary side. Thus, the proposed converter achieves high boost ratio and high efficiency over a wide range of input voltages. The steady-state waveform of the converter is similar to the hybrid resonant converter in, but doubles the boost ratio without having to use the secondary diodes.

Thus, the proposed design reduces the transformer turn ratio, transformer size, and the number of semiconductor devices, thereby reducing the size and cost of the converter. The same topology appeared in, but the operational characteristics are quite different. In, the secondary side switches are used to balance the secondary voltage without having to use the additional balancing-circuit, whereas in this paper, the secondary switches are used to boost the resonant inductor current by forming a closed circuit. Forming sources fashioned by diesel generators or micro-turbines. If the micro-grid is islanded, the dispatchable generation has to come up with a varying load and making of the renewable energy sources.

In order to diminish the common-mode voltage, the parasitic capacitor between the primary and secondary sides of the transformer wants to be concentrated, which leads to the enlarge in the leakage inductance and causes the higher voltage spike on the main power switch. The higher voltage rating is required for the higher voltage spike, the better on-resistance of the main power switch occurs to cause higher conduction loss and lower efficiency of the circuit. Therefore, the turn-off snubber and active clamp circuits were presented to suppress the turn-off voltage spikes.
RELATED WORKS
Analysis and Design of Maximum Power Point Tracking Scheme for Thermoelectric Battery Energy Storage SystemRae-Young Kim, Student Member, IEEE, Jih-Sheng Lai, Fellow, IEEE, Ben York, Student Member, IEEE, and Ahmed Koran, Student Member, IEEEThe analysis and design of an adaptive maximum power point tracking (MPPT) scheme using incremental impedance are presented. A small-signal model is mathematically derived, and the impact of two major design parameters, which are scaling factor and sampling interval, is analyzed in the frequency domain. Four factors which specifically affect the MPPT response are also clearly addressed. Based on this analysis, a design methodology to achieve a desirable transient response, while retaining system stability, is developed. The design methodology is implemented and verified with hardware experiments on a thermoelectric generator battery energy storage system, which indicate agreement between dynamic response and target bandwidth. Disadvantages: Less energy efficiency, Less efficiency Maximum Power Point Tracking Converter Based on the Open-Circuit Voltage Method for Thermoelectric Generators Andrea Montecucco, Student Member, IEEE, and Andrew R. Knox, Senior Member IEEEThermoelectric generators (TEGs) convert heat energy into electricity in a quantity dependant on the temperature difference across them and the electrical load applied. It is critical to track the optimum electrical operating point through the use of power electronic converters controlled by a Maximum Power Point Tracking (MPPT) algorithm. The MPPT method based on the open circuit voltage is arguably the most suitable for the linear electrical characteristic of TEGs. This paper presents an innovative way to perform the open-circuit voltage measure during the pseudo-normal operation of the interfacing power electronic converter. The proposed MPPT technique is supported by theoretical analysis and used to control a synchronous buck-boost converter. The prototype MPPT converter is controlled by an inexpensive microcontroller, and a lead-acid battery is used to accumulate the harvested energy. Experimental results using commercial TEG devices prove that the converter accurately tracks the maximum power point during thermal transients. Precise measurements in steady state show that the converter finds the maximum power point with a tracking efficiency of 99.85%.

Disadvantages:
High energy consumption
High cost.A Low Cost Fly back CCM Inverter for AC Module ApplicationYanlin Li, Student Member, IEEE, and Ramesh Oruganti, Senior Member, IEEE The unfolding-type fly back inverter operating in discontinuous conduction mode (DCM) is popular as a low-cost solution for a photovoltaic (PV) a module application. This paper aims to improve the efficiency by using a scheme based on continuous conduction mode (CCM) for this application. Design issues, both for the power scheme and the control scheme, are identified and trade-offs investigated. An open-loop control of the secondary current, based on feedback control of the primary current, is proposed in order to bypass the difficulties posed by the moving right half plane zero in the duty cycle to secondary current transfer function. The results presented show an improvement of 8% in California efficiency compared to the benchmark DCM scheme for a 200-W PV module application. The output power quality at rated power level is capable of meeting IEC61727 requirements. The stability of the fly back inverter in CCM has been verified at selected working conditions. Disadvantages: Energy has it be measured for energy week. Provides limited number of activities. Discrete-Time Repetitive Control of Flyback CCM Inverter for PV Power Applications Sung-Ho Lee, Woo-Jun Cha, Bong-Hwan Kwon, Member, IEEE, and Munsung Kim, Member, IEEE In this paper, a discrete-time repetitive controller (RC) is proposed for fly back inverter operating in continuous conduction mode, which has simple structure, low cost, and high efficiency. Conventional controller results in poor control performance due to the effect of the right-half plane zero in CCM operation. To achieve the accurate tracking performance and disturbance rejection, the repetitive controller is developed and applied to fly back inverter in CCM operation. In the RC scheme, a low-pass filter is used to allow tracking and rejection of periodic signals within a specified frequency range. A phase lead compensator is also used to compensate for the system delay caused by digital implementation. The stability of the closed loop system is derived and the zero tracking error is achieved. Numerical simulations validated the proposed control approach, and experimental tests using a 200-W digitally-controlled module integrated converter prototype confirmed its feasibility.

Disadvantages:
The impact of penalty is high. More man power is needed. A New Phase-Shifted Full-Bridge Converter With Voltage-Doubler-Type Rectifier for High-Efficiency PDP Sustaining Power ModuleWoo-Jin Lee, Student Member, IEEE, Chong-Eun Kim, Student Member, IEEE, Gun-Woo Moon, Member, IEEE, and Sang-Kyoo Han, Associate Member, IEEEA new phase-shifted full-bridge converter with a voltage-doubler-type rectifier for a high-efficiency power sustaining module of a plasma display panel is proposed in this paper. The proposed converter employs a voltage-doubler rectifier without an output inductor. Since it does not have an output inductor, the voltage stresses of the rectifier diodes can be clamped at the output voltage level. Thus, since no dissipative resistor—capacitor snubber for rectifier diodes is needed, high-efficiency low-noise output voltage can be realized. Due to the elimination of the large output inductor, it features simpler structure, lower cost, smaller mass, and lighter weight. Furthermore, the proposed converter has wide zero-voltage-switching ranges of lagging leg switches with low current stresses of the primary power switches by using the magnetizing current. In addition, the resonance between the leakage inductor of the transformer and the rectifier capacitors can reduce the current stresses of the rectifier diodes and conduction losses.
In this paper, the operational principles, analysis, design considerations, and experimental results are presented. Disadvantages: Less efficiency. High power consumption Phase-Shifted Full-Bridge Series-Resonant DC-DC Converters for Wide Load Variations Yu-Kang Lo, Member, IEEE, Chung-Yi Lin, Min-Tsong Hsieh, and Chien-
Yu Lin. This paper presents the design of a phase-shifted fullbridge series resonant converter (PS-FB SRC). The proposed FB SRC features a novel two-mode operation. It is operated in series resonant mode at normal loads. The switching frequency is varied to regulate the output voltage. The fixed-frequency phase-shifted pulse width modulation, on the other hand, is used to adjust the effective duty cycle and regulate the output voltage at light loads. The proposed converter exhibits high conversion efficiency for wide-range load conditions. The relationships among the voltage gain, the switching frequency, and the effective duty cycle are discussed and analyzed. Finally, a 48-V/42-A prototype is implemented. Experiments are conducted to verify the theoretical analysis. Disadvantages: High cost.

PROPOSED SYSTEM
A hybrid resonant dc/dc converter based on active voltage-doubler rectifier. When the input voltage is higher than the nominal input voltage, this converter operates in PSFB-SRC mode that achieves high power conversion efficiency by softly switching the primary side switches and reducing the conduction loss.

The converter operates in the resonant boost mode that can boost the resonant inductor current by using the active voltage-doubler rectifier on the secondary side. It provides soft switching on all primary switches and rectifier diodes reduces circulating current reduce voltage stress on the rectifier diode and is simple in circuit. A hybrid resonant DC/DC converter based an active voltage -doubler rectifier. Thus the proposed design reduce the transformer turn ratio transformer size and the number of semiconductor devices their by reducing the size and cost of the converter.

High efficiency over wide range of input voltage.

DC-DC CONVERTER
DC to DC converters are used in movable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often comprise several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes advanced or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is exhausted. Switched DC to DC converters offer a technique to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple series to accomplish the same thing. Most DC to DC converter circuit also organizes the output voltage. Certain exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and humble casualty pumps which double or triple the output voltage. DC to DC converters urbanized to exploit the energy harvest for photovoltaic systems and for wind turbines are called power optimizers. Modifiers used for voltage conversion at mains frequencies of 50–60 Hz must be large and heavy for powers above a few watts. This makes them expensive, and they are subject to drive losses in their windings and due to eddy currents in their cores. DC-to-DC techniques that employ transformers or inductors work at many superior frequencies, requiring only much smaller, lighter, and cheaper wound components. Consequently these methods are used even where a mains transformer could be used; for example, for domestic electric appliances it is preferable to rectify mains voltage to DC, use switch-mode methods to convert it to high-frequency AC at the desired power, then, usually, rectify to DC. The entire complex circuit is cheaper and more efficient than a simple mains transformer circuit of the similar output.

HYBRID H-BRIDGE
A hybrid H-bridge inverter contains a series of H-bridge inverter units. The general function of this Multi-level inverter is to synthesize a desired voltage form several DC bases (SDCSs). Each SDCS is connected to an H-bridge inverter. The AC terminal voltages of dissimilar level inverters are connected in series. Unlike diode lock or flying capacitors inverters the hybrid H-bridge inverter does not need any voltage clamping diodes or voltage-balancing capacitors. Cross multilevel converters have been presented. In the hybrid topologies, the dc voltage sources magnitudes are unsatisfactory or changed dynamically. These converters reduce the size and cost of the inverter and recover the reliability since less number of semiconductors and capacitors are used in this topology. The hybrid multilevel converters comprises of dissimilar multilevel topologies which are having unequal values of dc voltage sources and different modulation methods. With suitable assortment of switching devices, the converter cost is considerably reduced. But, the application of different multilevel topologies consequence in loss of modularity and produces problems with switching frequency and restrictions on the inflection and control method.

HYBRID MULTILEVEL TOPOLOGY
A cascaded H-bridge converter with equal dc voltage is widely used for STATCOM request. The cascaded single-phase H-bridge converter saves a large amount of clamped diodes and flying capacitors compared with diode clamped converter and hovering capacitor converter. In high-power application further improvement of power competence and waveform quality is expected of cascade Hbridge topology. Either by increasing switching frequency or number of cascaded modules, a low one-sided ac voltage waveform can

**Fig 1 block diagram**

**DC-DC block diagram**

**FLYBACK CONVERTER**

**TRANSFORMER**

**FILTER**

**RECTIFIER**

**REGULATOR**

**MICRO CONTROLLER**

**FIRING CIRCUIT**

**DC SUPPLY**
be attain but which may results in high power loss or high cost to the STATCOM system. A good compromise between waveform excellence and switching loss can be obtained by hybrid multilevel technology. Increased voltage levels of output waveform, improved ac present quality, reduced switching frequency resulting in low switching loss and also enhanced converter efficiency are the main compensations of hybrid multilevel converters.

Many hybrid multilevel approaches have been deliberated in literature. Compared with conventional ones this topology successfully produces superior voltage levels with identical number of switches but faces a difficulty of dc voltage control. All dc-link powers are controlled by controlled purely by control algorithm. Hybrid multilevel topology based on cascaded single-phase H-bridge converter with uneven dc voltage is discussed. A high voltage converter fed by dc provisions and a low voltage converter fed by dc capacitor in the literature. In high voltage inverter is performed by a diode clamped H-bridge with multi production boost rectifier. The clamped diode and rectifier makes the whole system costly. In literature fundamental frequency inflection is adopted for cascaded hybrid Hbridge converters. Selective harmonic elimination method is used for hybrid modulation in poetry and for capacitor voltage control selecting switching redundant states is applied. But the output voltage waveform quality is not good which prevents this technique for STATCOM application.

HYBRID MODULATION

Hybrid inflection is shown in Fig which includes two parts: fundamental modulation and pulse width modulation. Fundamental modulation is defined as: when the sinusoidal power command is greater than a positive threshold value of Vcmp high voltage converter outputs positive voltage; when the sinusoidal voltage command is lower than the undesirable threshold value of Vcmp high voltage converter outputs negative voltage and if sinusoidal command is in range between Vcmp and Vcmp high power converter outputs zero. Residual part of sinusoidal command and quasi square waveform voltage is command voltage for low voltage converter. It is moderated by single-polar PWM modulation knowledge with the carrier frequency of 5 kHz. Based on this modulation plan, an ac waveform with higher voltage levels is produced. It brings the advantages of improving output quality, keeping high equivalent substituting frequency, and reducing power loss.

CONTROL STRATEGY

The overall control system consists of:

- Decoupled Current Control
- Command Current Generating Control
- Capacitor Voltage Control
- Cluster balancing control
- Individual Voltage Balancing Control
In developing a dc/dc converter that is highly efficient over a wide range of Vin, we propose to use an active Voltage-doubler rectifier in the secondary side of the converter. When Vin > Vin nom, the proposed converter operates in the PSFB-SRC mode and achieves high efficiency by providing all switches with soft-switching capabilities. Otherwise, it operates in resonant boost mode that enables voltage step up by using an active voltage-doubler rectifier. Furthermore, implementing the active voltage-doubler rectifier on the secondary side can reduce the size and cost of the fabricated converter. To confirm the validity of the proposed converter, a 600-W prototype converter was built and tested. Under the designated operation range, it achieved 98.3 % peak efficiency Under PSFB-SRC with full phase-shift mode and 96.6 % peak efficiency under the resonant-boost mode.

REFERENCE


CONCLUSION

In developing a dc/dc converter that is highly efficient over a wide range of Vin, we propose to use an...